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NPOESS Satellite Cal/Val Panel

Microwave Sensor Design - Atmosphere

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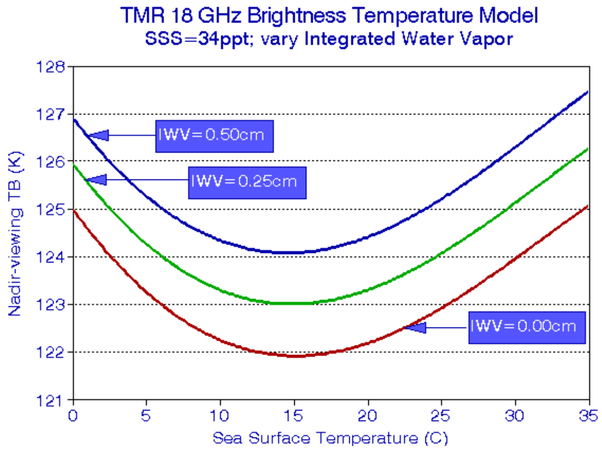
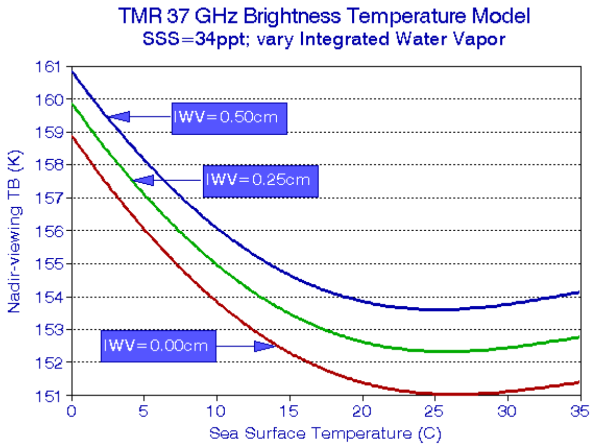
Outline

- Vicarious Cold Reference Calibration
  - TOPEX Microwave Radiometer detection of drift in 18 GHz channel calibration
  - SSM/I verification of sharp lower bound on TB distribution
- Case Study – Recent Cal/Val of the Jason Microwave Radiometer
  - Vicarious Cold Reference
  - Amazon Rain Forest and Sahara Desert Hot Reference
  - The value of tandem TMR/JMR measurements

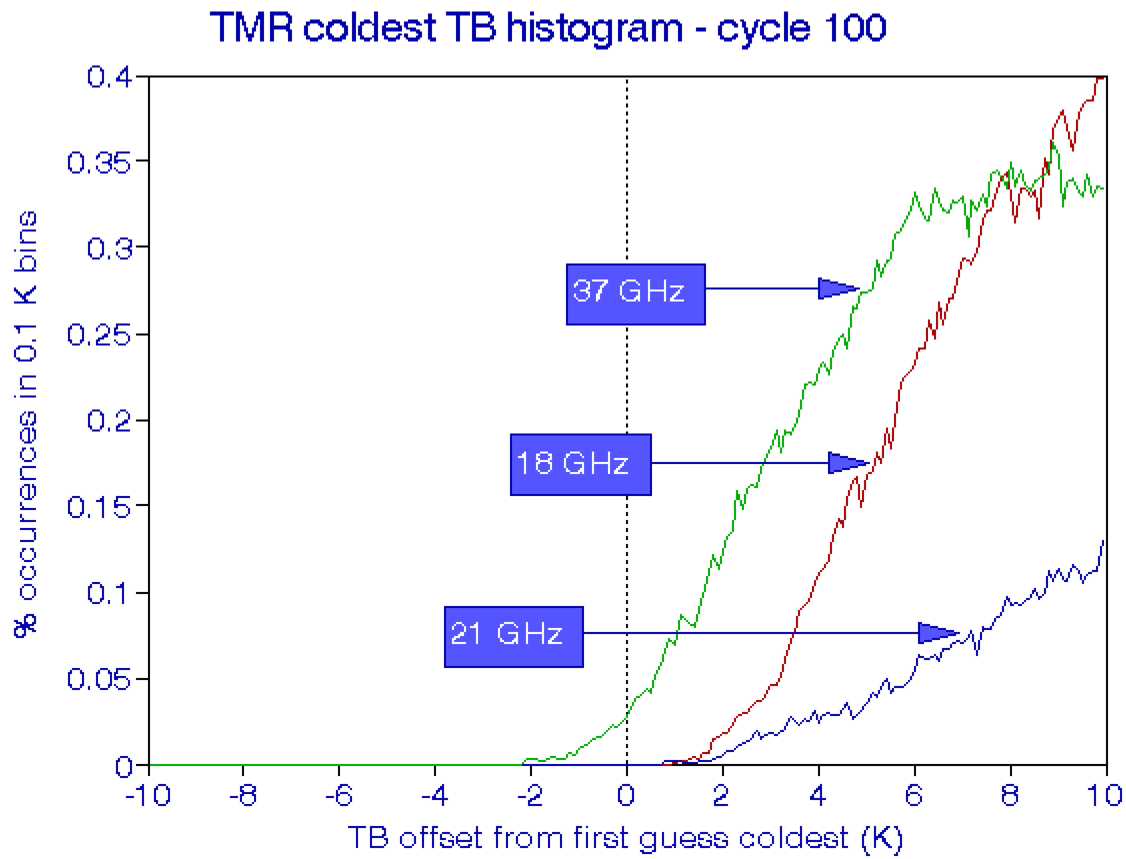
Vicarious Cold Reference - Minimum TB seen by window channels

- Minimum TB conditions
  - No Clouds or Wind
  - Low humidity
  - Optimum SST (vs. freq.)
  - (weak SSS dependence)
- TB versus SST shown at 18 and 37 GHz nadir-viewing using Ellison et al. [1998] ocean permittivity model with no clouds or wind



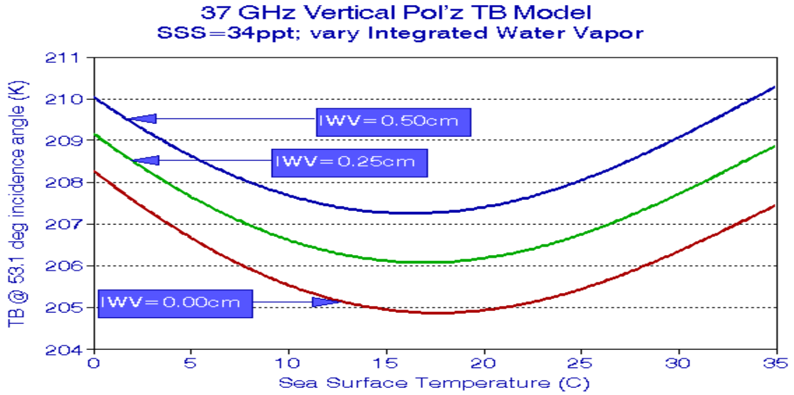


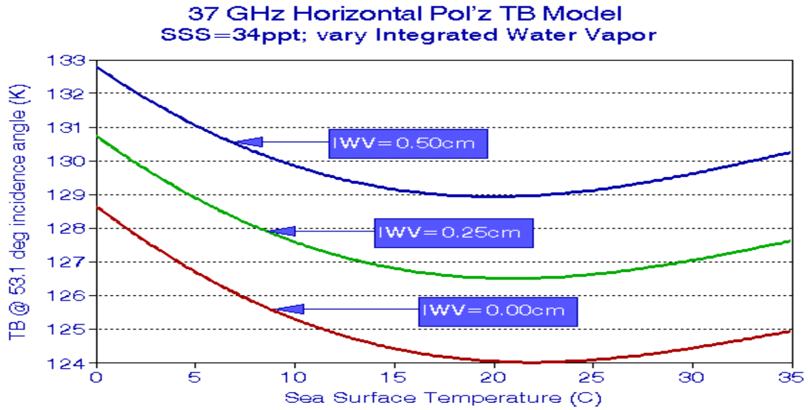
Sample Cold TB Histogram



Extension of Vicarious Cold Reference from Nadir to Oblique Incidence

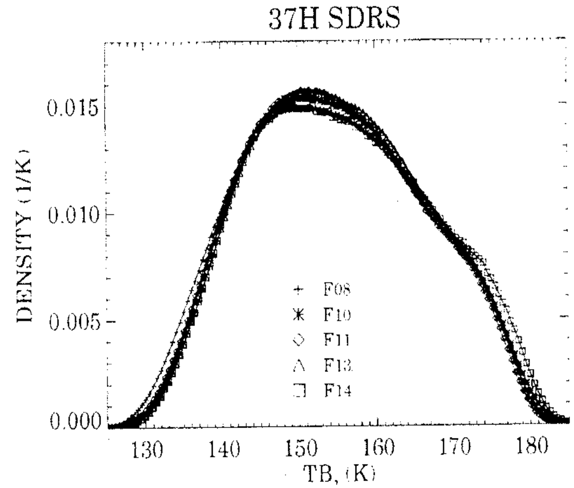
- TB at off-nadir angles also have minimizing SSTs
- *e.g.* 37 GHz @ 53.1 deg:
  - SST=16-17C @ V-pol
  - SST=20-21C @ H-pol
- Corresponding IWVs
  - 0.37 cm @ 16.5 C
  - 0.40 cm @ 20.5 C
- Corresponding TBmin
  - 128.0K (H-pol)
  - 206.6K (V-pol)

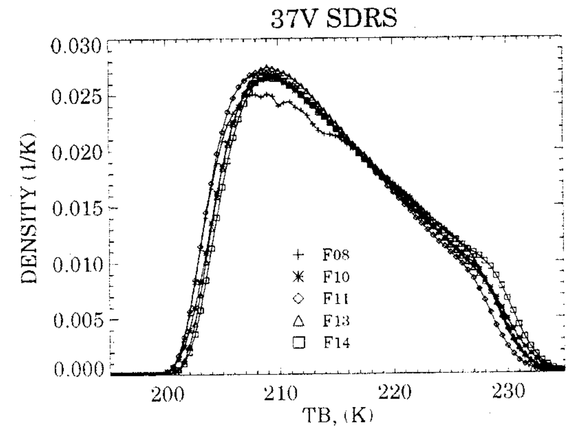




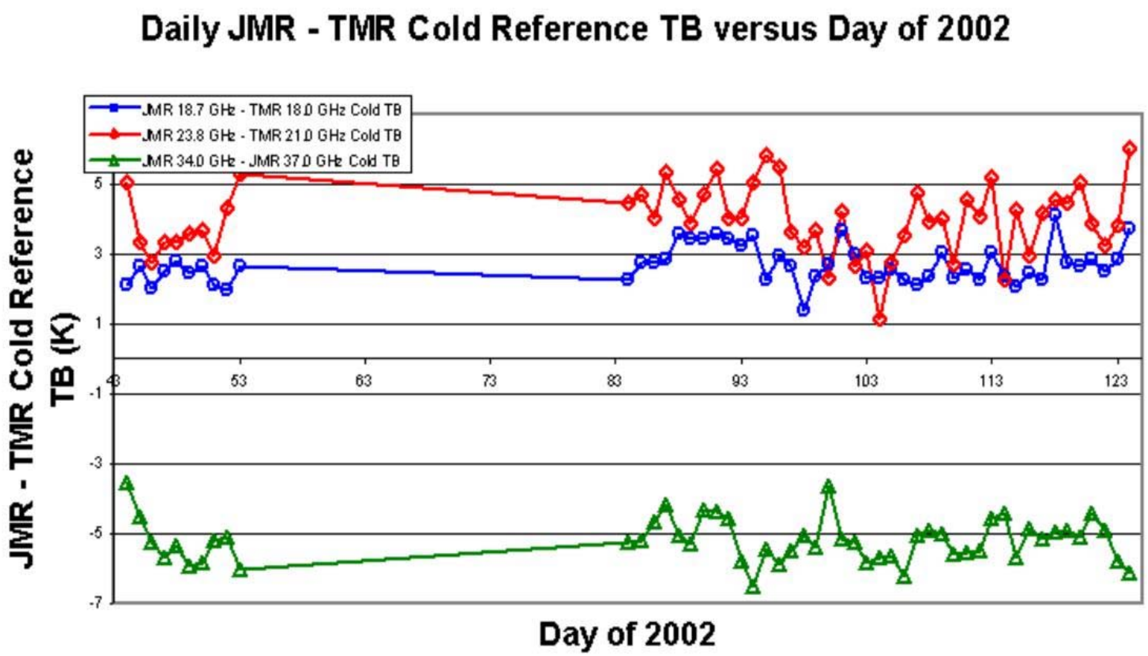
Test of Vicarious Cold Reference at 37 GHz, 53.1 deg using SSM/I Histograms

- Recent SSM/I histogram analysis [Colton & Poe, IEEE TGARS, 37(1), 418-439, 1999]
- 5 platforms over '91-'97; non-precipitating & over ocean
- 37H lower bound agrees well
  - Pure H-pol is lowest TB
- 37V lower bound ~4K lower (even with IWV=0 cm)
  - Any H-pol mixing will lower TB
  - Possible uncorrected polarization mixing?
  - Good H-pol lower bound => maybe scan angle dependent polarization mixing



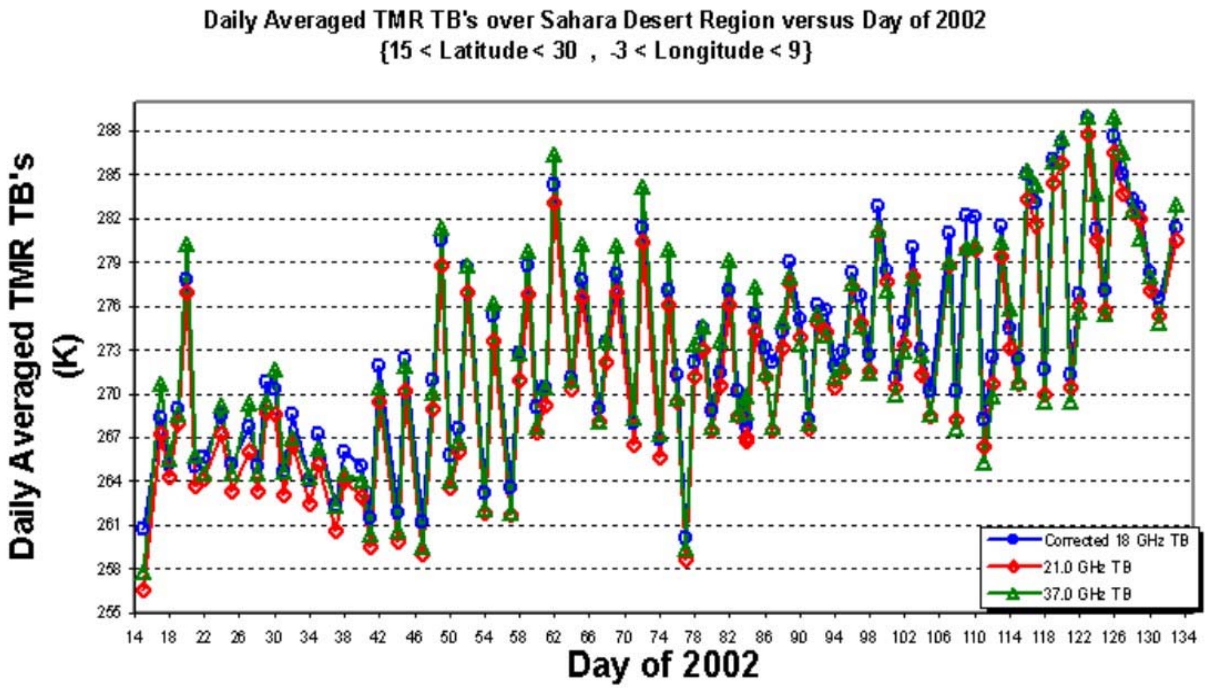


JMR-TMR Cold TB Difference Obs



- Average Cold TB Differences over all days shown (sinusoidal yaw state only) to get baseline offsets between TMR and JMR TB calibrations at cold end of range

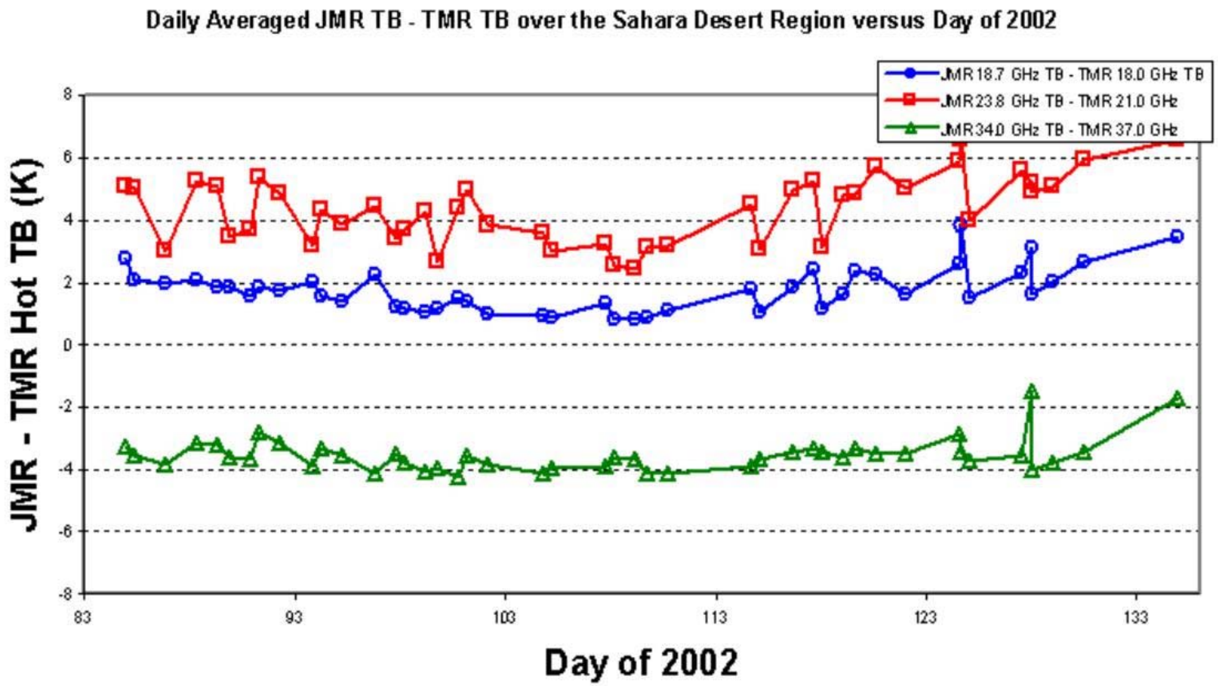
TMR Hot TB Reference
The Sahara Desert



- Hot TB is spectrally flat
- Rise in TB (at all frequencies) is likely seasonal

(note: TBs shown use APC algorithm corrected for over-land conditions)

JMR-TMR Hot TB Reference



- Average Hot TB Differences over all days shown (sinusoidal yaw state only) to get baseline offsets between TMR and JMR TB calibrations at hot end of range

JMR TB Calibration Correction

- *Ad hoc* correction algorithm is a linear interpolation between cold and hot bias corrections for intermediate TB levels
- Adjustments to actual Level 0&1 algorithms will be implemented via corrections to hardware path loss and antenna beam fraction coefficients
  - First look indicates that the adjustments needed are of reasonable magnitude

JMR TB Calibration Correction, cont.

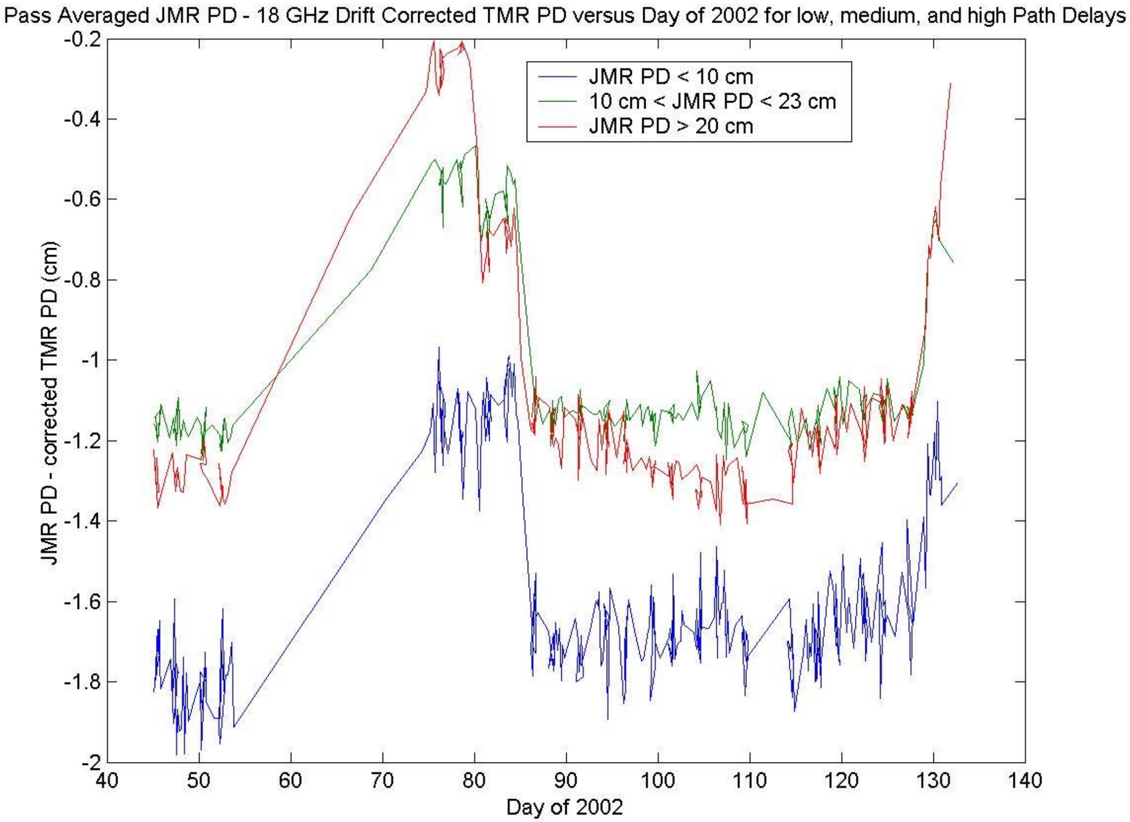
Correction Algorithm:

$$TB_{corrected} = TB_{GDR} - \Delta TB_{cold} - (TB_{GDR} - TB_{cold})\frac{\Delta TB_{hot} - \Delta TB_{cold}}{TB_{hot} - TB_{cold}}$$

Algorithm coefficients:

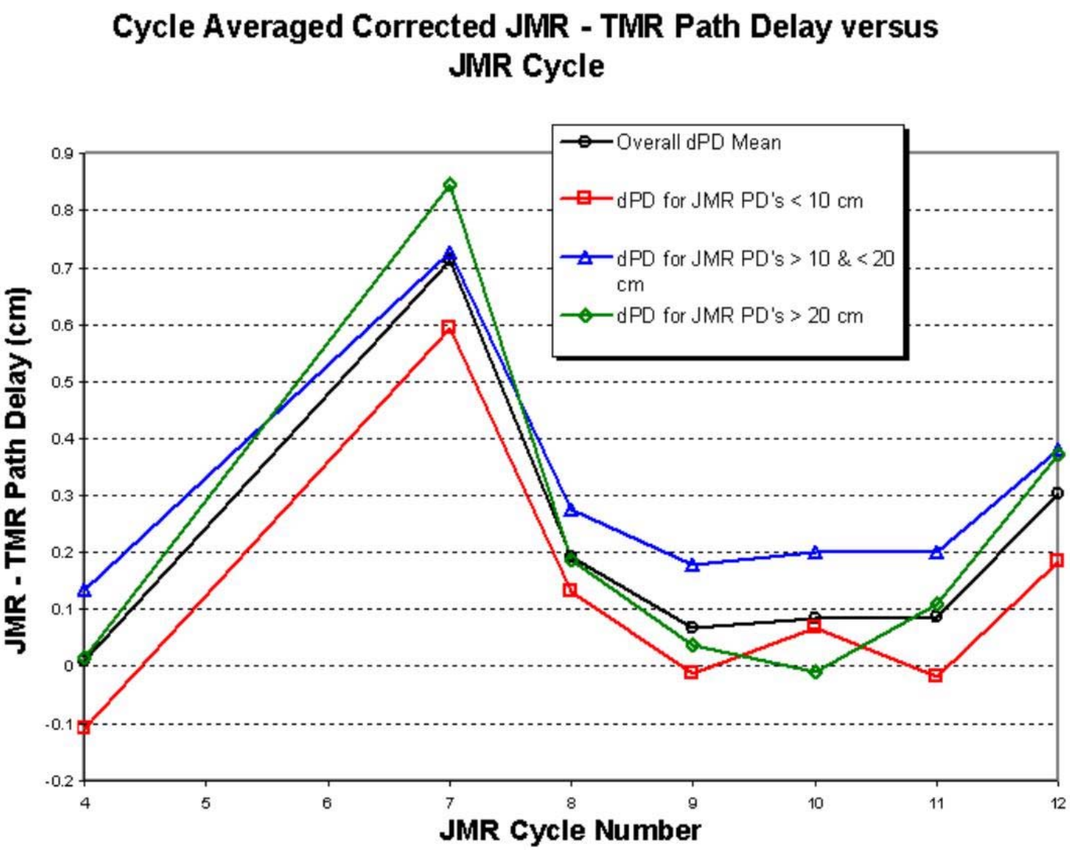
Coefficients in JMR TB correction algorithm			
	18.7 GHz	23.8 GHz	34.0 GHz
ΔTB_{cold}	1.54	-1.31	0.46
TB_{cold}	125.3	134.6	147.9
ΔTB_{hot}	-4.0	-2.1	-10.0
TB_{hot}	278.5	278.5	278.5

JMR-TMR PD Comparison Before JMR TB Corrections



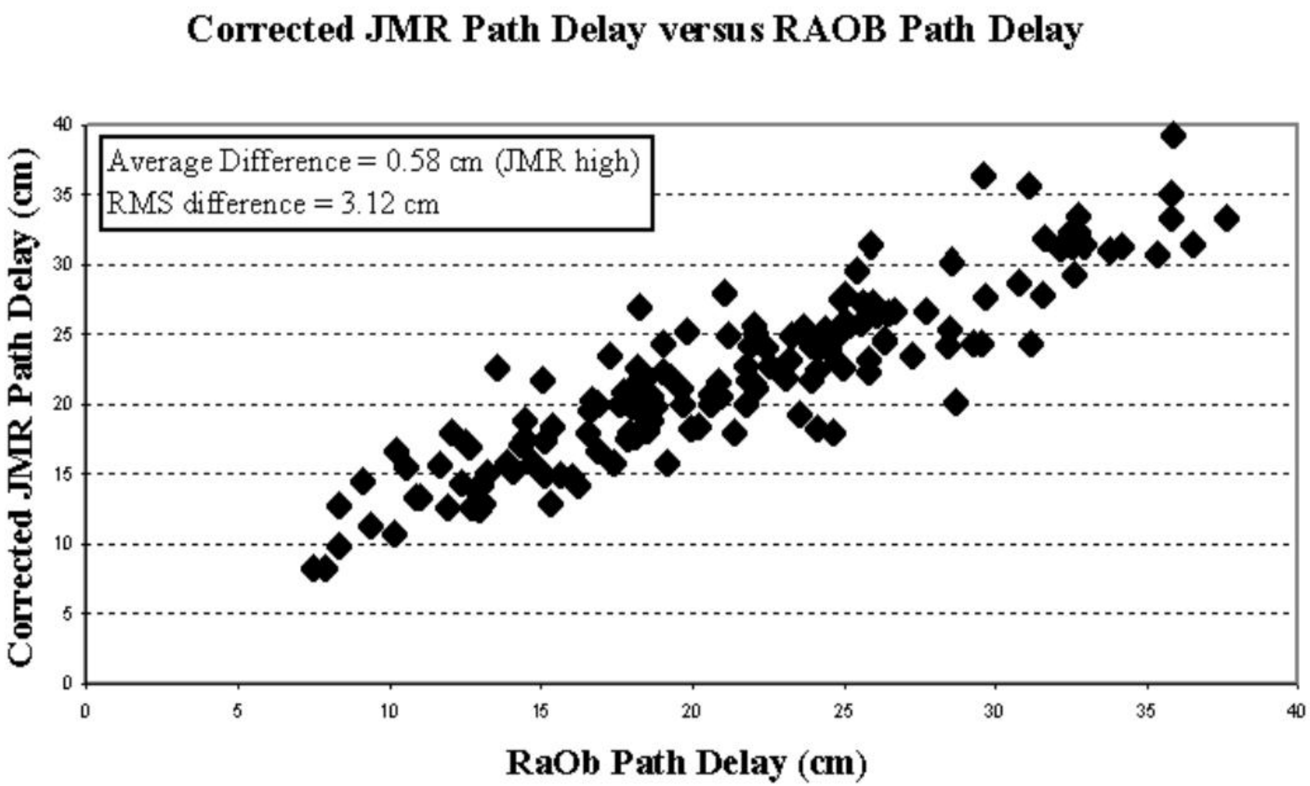
- Large PD errors present at all levels of PD
- PD errors largest at low (driest) PDs

JMR-TMR PD Comparison After JMR TB Corrections



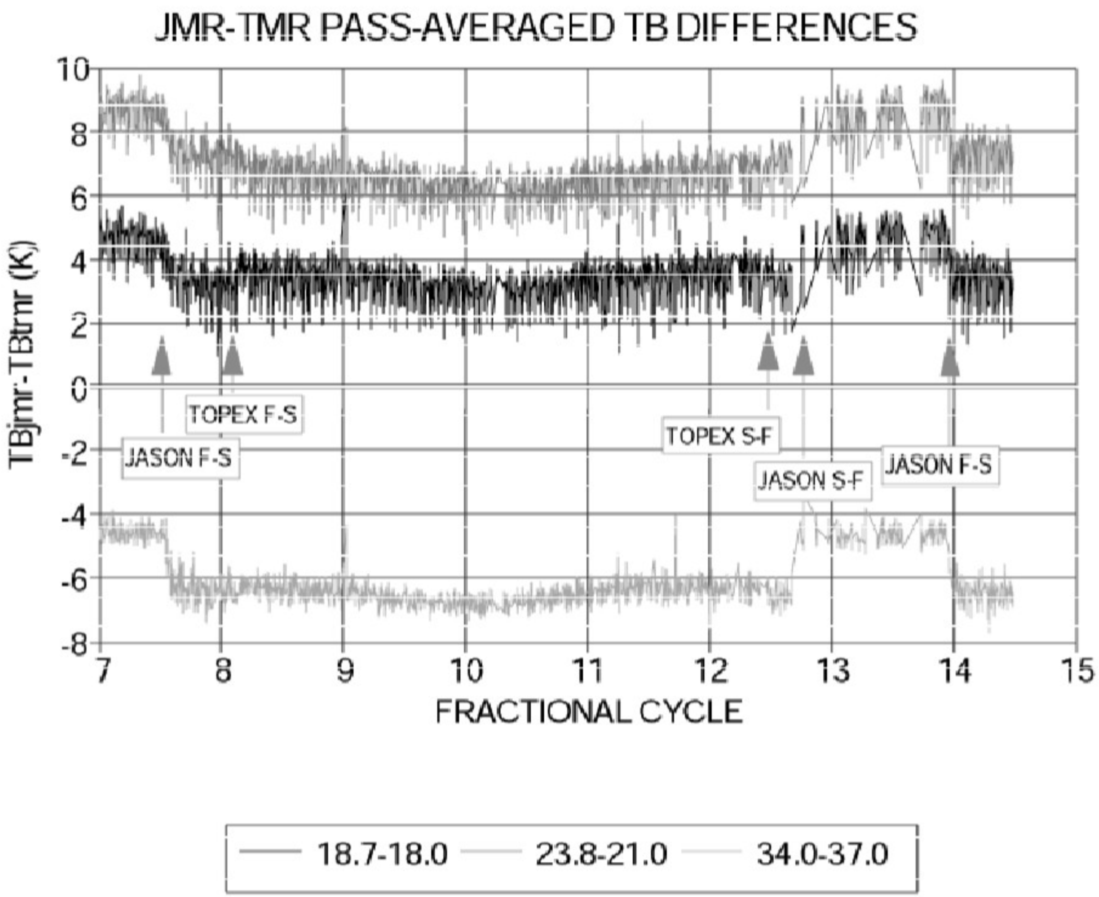
- PD biases have been largely removed after JMR TB corrections at low, medium and high ranges of PD during sinusoidal yaw state
- Large PD biases are associated with fixed yaw state
  - TOPEX fixed-to-sinusoidal yaw maneuver (F-S) occurs in early cycle 7
  - TOPEX S-F occurs in mid cycle 12

JMR v. RaOb PD Comparison after JMR TB Corrections



- Open ocean island RaObs within 315 km and 6 hours of closest approach overpass during DOY 15-134 of 2002, clear skies only, N=150 samples

Evidence of TB Shifts by both TMR and JMR due to s/c Yaw State

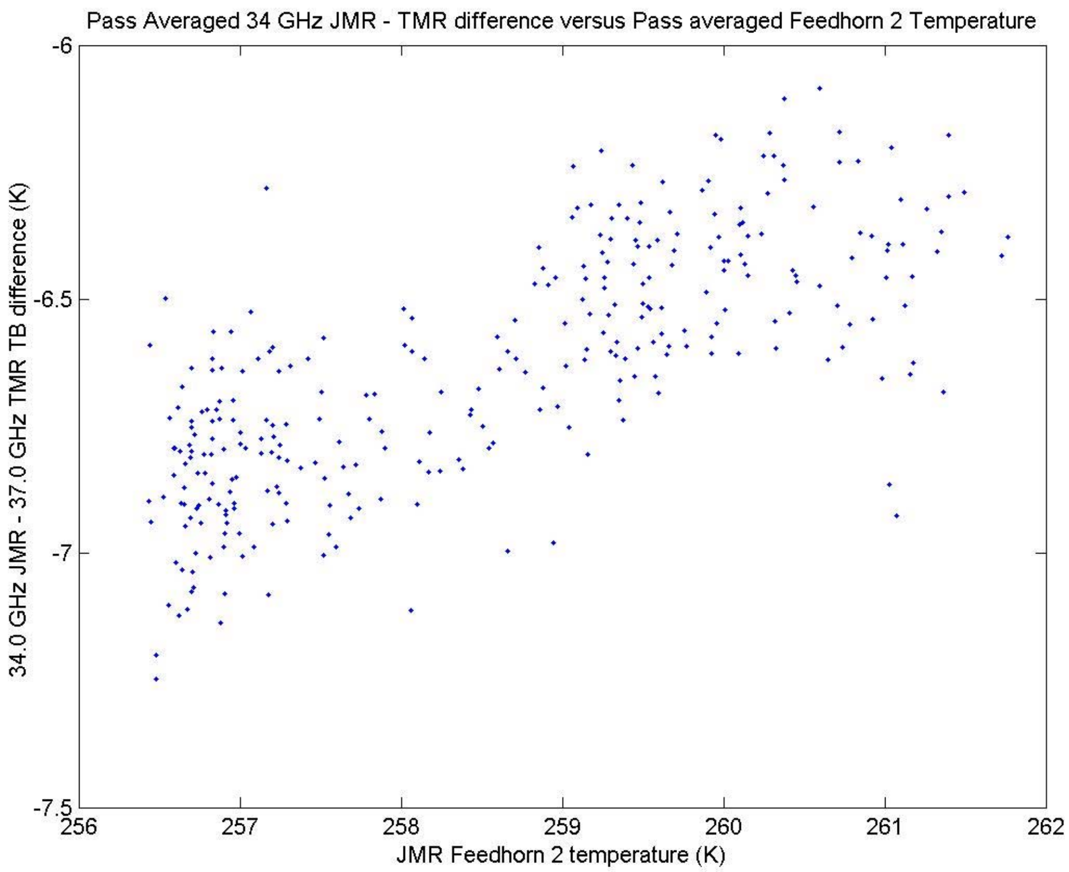


- TOPEX fixed/sinusoidal yaw
  - TMR TBs change <0.5K
  - Changes in opposite directions between channels
- Jason-1 fixed/sinusoidal yaw
  - JMR TBs change 1-2K
  - Changes in same direction between channels

Yaw Anomaly
Closer Looks at Its Behavior

- JMR Cold Reference TBs Shift with Yaw State
  - Independent confirmation that doesn't involve TMR
- JMR-TMR TBs are strongly correlated with key JMR hardware physical temperatures
  - Level 0 loss coefficients need to be adjusted

JMR_TB34 – TMR_TB37 is strongly correlated with feedhorn temperature – path loss coefficients need correction



JMR feed horn temperature shift during yaw maneuver